



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b> <b>H01F 41/26, G08B 13/24</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 90/07784</b> <b>(43) International Publication Date:</b> 12 July 1990 (12.07.90)
<b>(21) International Application Number:</b> PCT/GB90/00024 <b>(22) International Filing Date:</b> 9 January 1990 (09.01.90) <b>(30) Priority data:</b> 8900398.2 9 January 1989 (09.01.89) GB <b>(71) Applicant (for all designated States except US):</b> SCIENTIFIC GENERICS LIMITED [GB/GB]; King's Court, Kirkwood Road, Cambridge CB4 2PF (GB). <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only) :</b> DAVIES, Dafydd, Geraint [GB/GB]; 19 Beche Road, Cambridge CB5 8HX (GB). <b>(74) Agent:</b> ABRAMS, Michael, John; Haseltine Lake & Co., Hazlitt House, 28 Southampton Buildings, Chancery Lane, London WC2A 1AT (GB).		<b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), BR, CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US.  <b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

**(54) Title:** MAGNETIC MATERIALS FOR SECURITY APPLICATIONS**(57) Abstract**

A tag or marker is disclosed which comprises a substrate; an 'active' magnetic material which is a soft magnetic material having a high magnetic permeability and a low coercive force; and a deactivating material which is a hard or semi-hard magnetic material having a moderate or high coercive force and a moderate magnetic permeability, whereby the deactivating material, when subjected to a sufficiently high magnetising force, is able to clamp the magnetic properties of the 'active' material so as to deactivate the 'active' material. The tag or marker is characterised in that at least one of said 'active' material and said deactivating material is formed by an electrodeposition process. In another aspect, the deactivating material is formed from a steel containing 0.15 % carbon, 16-18 % chromium, and 6-8 % nickel, the balance being iron.

***FOR THE PURPOSES OF INFORMATION ONLY***

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MR	Mauritania
BE	Belgium	GA	Gabon	MW	Malawi
BF	Burkina Faso	GB	United Kingdom	NL	Netherlands
BG	Bulgaria	HU	Hungary	NO	Norway
BJ	Benin	IT	Italy	RO	Romania
BR	Brazil	JP	Japan	SD	Sudan
CA	Canada	KP	Democratic People's Republic of Korea	SE	Sweden
CF	Central African Republic	KR	Republic of Korea	SN	Senegal
CG	Congo	LI	Liechtenstein	SU	Soviet Union
CH	Switzerland	LK	Sri Lanka	TD	Chad
CM	Cameroon	LU	Luxembourg	TG	Togo
DE	Germany, Federal Republic of	MC	Monaco	US	United States of America
DK	Denmark				

MAGNETIC MATERIALS FOR SECURITY APPLICATIONS

This application relates to magnetic materials and their use in tags or markers in systems for security tagging, anti-pilferage, article location and article  
5 identification.

Anti-pilferage tags or markers are applied to articles of commerce in order to protect them from theft from the sale premises. Similar tags are applied to articles or persons for stock control or  
10 identification purposes, being detected when the articles or persons pass or attempt to pass pre-selected detection stations. The markers are also attached to fixed articles which may be concealed, encased or covered over by other structures or  
15 materials; in this case, the articles to which the markers are attached are located by the use of a portable marker detector.

In order to achieve the desired magnetic properties, and in order to minimise the overall size and manufacturing cost of the marker, it is  
20 advantageous to manufacture magnetic elements of the marker in the form of thin sheets, foils, or films. There are usually two components to such markers. One is an 'active' magnetic material which has soft  
25 magnetic properties, i.e. high permeability and low coercive force (under  $100 \text{ Am}^{-1}$ ). The second component is a semi-hard or hard magnetic material, which is often referred to as a 'deactivation' material, and which has a medium permeability and a medium to hard  
30 coercive force (over  $1000 \text{ Am}^{-1}$ ). The active material produces the detectable signal, and the semi-hard or hard component produces a switchable dc magnetic field which biases or suppresses the response of the active material under appropriate conditions. Both types of  
35 material are currently produced using comparatively expensive alloys and processes to achieve the special

magnetic properties required. Examples of current alloys are Vacozet, Vitrovac and Crovac from  
Vacuumschmeltze in Germany; and Arnokrome from Arnolds  
in the USA. We have identified materials and processes  
5 which may result in cheaper production of the magnetic components.

According to one aspect of the invention, there is provided a magnetically active tag or marker which comprises a substrate; an 'active' magnetic material  
10 which is a soft magnetic material having a high magnetic permeability and a low coercive force; and a deactivating material which is a hard or semi-hard magnetic material having a moderate or high coercive force and a moderate magnetic permeability, whereby the  
15 deactivating material, when subjected to a sufficiently high magnetising force, is able to clamp the magnetic properties of the 'active' material so as to deactivate the 'active' material, characterised in that at least one of said 'active' material and said deactivating  
20 material is formed by an electrodeposition process.

Thus at least one of the 'active' material and the deactivating material is produced by a technique such as electrodeposition, electroforming or electroless chemical deposition. These processes are advantageous  
25 for producing thin foils of material with well-defined properties at low cost. They involve deposition of a metal or metallic alloy film from a liquid containing the metallic ions in solution, such as a nickel sulphamate solution; deposition being driven either by  
30 electric current or by chemical catalysis. With electroforming, the film is formed onto a mould, die, template, tool or mandrel, and may then be removed as a free-standing foil. The addition of small quantities of organic molecules to the working solution is used to  
35 control the stress in the electroformed film. In electrodeposition, the foil is usually deposited onto a

metallic or conducting substrate or carrier from which it is not subsequently removed, while in electroless deposition the substrate need not be conducting. A further advantage of using such deposition processes is that the foil may also be formed as discontinuous elements (e.g. dots or islands) or as a sheet with holes, without material cutting or waste, since the area of deposition can be controlled by a simple masking technique. We have discovered that this masking can be achieved either by screen printing of a non-conducting ink or paint onto the metallic substrate, or by the use of an ink roller with a suitable pattern. Alternatively, a reusable mask may be pressed against the substrate during deposition, or photolithographic masking can be used. Another method is to fix non-conducting areas of material such as polymer or resin onto the former or mandrel in the electroforming process. A discontinuous film, or one containing a plurality of holes, is advantageous because the non-uniform shape enhances the magnetic effect of the component in the marking system, particularly the effect of the semi-hard or deactivating element. The ability to form a discontinuous or hole-permeated film or foil in one single process, without the need to subsequently cut or remove material, leads to considerable cost savings in the manufacturing process.

These deposition processes are attractive for forming thin films below about 100 microns, and in particular for films below about 40 microns, since the process costs are lower than for rolling or casting processes, and they are particularly cost-effective for films in the thickness range 5-25 microns. A further advantage of these processes is that the magnetic properties are usually isotropic or uniform in the film plane, so that the materials do not have to be

specially oriented during manufacture of the markers. The magnetic performance of the components is thus also isotropic, leading to a better performance of the marker. In contrast, rolled or cast materials tend to have a strong anisotropy - for example, the coercive force may vary by a factor of two for different directions in the film plane, requiring that the material be aligned along specific directions during manufacture of the marker.

The crystal grain structure produced by these deposition processes is often columnar in nature, i.e. long thin crystals with the long axis perpendicular to the foil plane. This gives the advantageous isotropic properties in the plane, as referred to above. For some applications, however, it is desirable to have anisotropic properties. We have discovered that this can be achieved by changing the additives to the electrolyte and changing the deposition conditions in order to achieve planar, rather than columnar, crystal growth. The conditions required to achieve planar grain growth (often referred to as a 'bright' deposition) would be known to a person skilled in these deposition techniques.

With columnar grains, the microscopic magnetic fields associated with the end faces of the columns may lead to unwanted magnetic effects, such as stray magnetic fields, when the material is nominally not magnetised. We have discovered that these effects may be diminished if a thin layer of planar-grain material is deposited on top of the isotropic, columnar material, to form a magnetic short-circuit for the unwanted microscopic magnetic fields.

We have discovered that a suitable material for the active or soft magnetic element is electrodeposited nickel-iron alloy with 60-100% Ni. Low magnetostriction is achieved with Ni at 75-80%. Some

subsequent heat treatment may be necessary if it is required to reduce the coercive force of the foil to a value below about  $20 \text{ Am}^{-1}$ .

Formation of the semi-hard magnetic component by these deposition processes is particularly attractive since in general this is the largest component by volume in the markers. The requirement of this component is a well defined coercive force in the range  $100\text{--}15,000 \text{ Am}^{-1}$  (depending on the design of the marker). We have found that suitable materials for this component, which can be manufactured in a manner described by this invention, include pure Ni, pure Fe, Ni-Co, Co and Co-W. With the alloys, the relative proportion of the second component is varied to produce the desired coercive force. Alternatively, the coercive force can be controlled by heat treatment such as annealing. We have fabricated electrodeposited samples of all the above materials to produce coercive forces in the desired range and with sufficiently high squareness of the magnetic hysteresis loop to give a magnetic remanence ratio ( $M_{\text{remanent}} + M_{\text{saturation}}$ ) of over 0.5. In particular, electroformed Ni produced on a drum mandrel can be rapidly and cheaply manufactured without undesirable residual stresses at thicknesses between 2 microns and 100 microns, and with coercive force easily controllable in the range  $5000\text{--}6000 \text{ Am}^{-1}$  without the need for heat treatment. Ni, Co and their alloys are also highly resistant to corrosion. We have found that electroformed Ni foil is also easily cut compared to currently used special alloys, so that pieces or holes may be easily stamped from the foils mechanically.

According to another aspect of the invention, the electrodeposited material is rendered magnetically discontinuous or non-homogeneous by a selective cold-forming or deformation process such as stamping,

rolling, processing or embossing. The deformation process changes the magnetic properties, in particular the permeability of the material in the plane of the foil. The purpose of this is that, as described previously, a pattern of changing magnetic properties enhances the structure and efficacy of the magnetic field of the material. The advantage of a deformation process is that it leaves a mechanically continuous foil, with little or no topographic variations, which is simpler and cheaper to handle in subsequent stages such as lamination, and which gives a more uniform surface finish in the final product. In addition, the deformation is simple to implement in comparison with foil masking, or cutting or removing pieces from the foil.

According to a further aspect of this invention, the semi-hard component may be manufactured from stainless steel in a suitable form such as rolled sheet, wire 'wool' or filings. We have discovered that, by careful control of Cr, C and Ni content in the steel, an alloy can be formed which has significant ferromagnetic content after cold-working (such as rolling) but which can be rendered non-ferromagnetic by a simple heat treatment. A commercially available stainless steel which satisfies the compositional criteria is type AISI 301 stainless steel, which contains up to 0.15% carbon, 16-18% chromium and 6-8% nickel. Cold rolling of the sheet (preferably to approximately 50% reduction) gives a coercive force in the range of 1000 - 5000 Am<sup>-1</sup>, generally of about 3000 Am<sup>-1</sup>, and high remanent magnetisation, so the material is suitable for the semi-hard (deactivating) element. The ferromagnetic content is due to the presence of a martensitic phase generated during cold-working. The martensite can be retransformed to non-magnetic austenite by a suitable heat treatment, such as heating



to approximately 800°C. The heating should not be maintained for any great length since prolonged high temperature treatment leads to the formation of carbides, which stabilises the martensite. However,  
5 the cooling rate should be sufficiently slow to allow time for the phase transformation to austenite to take place.

This phase transformation is of great advantage since by selective area heat treatment, a continuous  
10 film or strip of stainless steel can be formed which has alternating regions of magnetic and non-magnetic material. As mentioned before, this enhances the effect of the semi-hard magnetic material on the active element. The selective heat treatment may for example  
15 be carried out by laser beam or electron heating, or by induction heating or localised resistive heating. Stainless steel also has the advantage over more conventional special magnetic alloys of being low-cost material, since it is widely commercially available.

20 The invention will be illustrated by the following Examples, which are of non-limiting of the scope of the invention. Reference is made, in the following, to the accompanying drawings, in which:

Figure 1a illustrates a press tool used in one  
25 embodiment of the invention;

Figure 1b is an enlarged view of a part of the tool shown in Figure 1a;

Figure 2 illustrates the pattern resulting from the use of the tool of Figure 1 in the cold working of  
30 a metal foil;

Figure 3 shows a schematic view of a heated press used for selectively annealing predetermined areas of a metal foil; and

Figure 4 illustrates schematically the result of  
35 using the press of Figure 3.

Reference will be made to the drawings in the

Examples which now follow.

#### EXAMPLE 1

This Example describes the manufacture of a deactivation material from electroformed nickel foil.

5 A continuous roll of electroformed plain nickel foil having a thickness of 20 microns was purchased from INCO Alloys Ltd in the UK. The foil was then annealed for 24 hours at a temperature of 280°C, followed by a 24 hour cooling period to room temperature. This

10 reduced the coercive force from 6000 kA/m to 2000 kA/m, which was the required value for this particular application. The finished material was in the form of a roll of width 50 cm. This roll was then slit to rolls of width 8 mm, and then used as the deactivator

15 supply material for lamination with other components in an anti-pilferage label manufacturing process.

#### EXAMPLE 2

This Example describes the manufacture of a hole-permeated foil of deactivation material using an

20 electroforming process. The same electrolytic process and conditions as in Example 1 were used, but the forming mandrel consisted of a titanium drum of width 50 cm, covered with a continuous array (based on a hexagonal lattice) of circular embedded epoxy resin

25 islands of diameter 1.5 mm and centre to centre spacing of 3 mm. The resin was embedded in depressions of the appropriate size machined into the titanium drum to a depth of 1 mm, and the resin was then machined back to be flush with the drum surface. Electroforming the

30 foil on this mandrel produced a 20 micron thick nickel foil which could be produced continuously and which had 1.5mm circular holes the pattern of which corresponded to the pattern of the epoxy resin islands. The foil was then annealed in the manner described in Example 1.

35 Finally, the foil was laminated to a continuous foil-like 'active' magnetic material which had been

deposited on a 25 micron polymer film. The advantage of this process is that the active material and the deactivation material may be handled as continuous webs for the lamination process, and thereby facilitated the production of a continuous web which could then be cut into deactivatable anti-pilferage markers of any required size.

### EXAMPLE 3

This Example describes the manufacture of a structurally continuous deactivation foil which is rendered magnetically discontinuous by a selective cold working process. The same nickel foil as that employed in Example 1 was used in this Example. The foil, of width 50cm, was fed into a flatbed parallel press as illustrated in Figures 1a and 1b. The press tool consisted of a lower face 1 formed of a mild steel which was machined to be smooth and flat; and an upper face 2 which was formed with a mesh of lines 3 arranged in a square grid array, the side of the square being 2.5cm. The upper face 2 was formed of a tool grade steel, and the square grid pattern 3 was formed by machining the array of grid lines to a depth of 0.5mm. (see Figure 1b). The press tool 1, 2 covered an area of 50cm x 2cm, so that by feeding the nickel foil through the press in a direction normal to the long side of the tool, and advancing the foil in steps of 2cm after each pressing operation, the entire continuous roll of foil could be treated easily. The result of using this press tool was to form a roll of foil carrying a deformation pattern 4 (see Figure 2) throughout its width and length, the pattern conforming to that of the grid array of Fig. 1b. In order to achieve the desired degree of plastic deformation in the lines 4 of the treated foil, without requiring cutting or significant bending of the foil, it was found that a press force in the range of 20 to 100 tons

weight per stroke of the press tool was required. Advantageously, the force was about 50 tons force. Below the lower limit of 20 tons, the resultant plastic deformation was insufficient to cause an adequate disruption of any magnetic circuit in the plane of the foil. The resultant continuous foil roll of deactivating material was then laminated to an active magnetic material (in the form of a foil) in a continuous process as described above in Example 2.

#### EXAMPLE 4

A nickel foil was pressed with a deformation pattern, as described above in Example 3, but in this Example a rotary embossing-type process was used in place of the flatbed press of Figure 1. The cylindrical rotary roller tools were of similar materials and patterns to those described in Example 2, but lower forces, in the range 2-10 tons force, were necessary because the instantaneous contact area was smaller in this example. This produced a similar material to that described in Example 3 but the foil could be processed more quickly and there was less tool wear in the rotary process.

#### EXAMPLE 5

This example describes the production of a deactivator material from a stainless steel. AISI type 301 stainless steel was cold-rolled to a thickness of 80 microns, and then fully thermally annealed until it was essentially non-magnetic. This foil was then cold-rolled to a thickness of 40 microns, at which degree of deformation it displayed a coercivity of 3 kA/m, and a remanence ratio of 0.8.

#### EXAMPLE 6

The foil produced by the method of Example 5 was suitable for use in the manner described above in Example 1, as a continuous and magnetically homogeneous deactivator foil or strip. Alternatively, the material

could be rendered magnetically discontinuous, giving a result analogous to the Ni material of Example 4; a technique for achieving this magnetically discontinuous state will now be described.

5           The steel foil was fed into a continuous flatbed press where the press tools were configured as shown in Figure 3, i.e. such that the lower plate 5 formed a flat-toothed metal clamp (having teeth 7) and the upper plate 6 had similar clamping teeth interleaved with  
10           heating elements 8. The elements were maintained at a temperature in the range of 800°C to 1200°C, preferably at about 1000°C, and pressed into contact with the rolled steel sheet (with very little pressure) for a duration of approximately 0.2 seconds. The flat teeth  
15           gripping the foil were cooled by a recirculating water system, and they serve to keep the non-heated areas of the foil, adjacent to the heated areas, at a low temperature so that they were not affected by the heating elements 8. By feeding the foil through the  
20           press, the rolled foil was covered with a continuous pattern of stripes of annealed and non-annealed material since the material in contact with the heating elements was annealed and became non-magnetic. The 'striped' foil was slit into reels of 2 mm width, and  
25           the reels were then laminated to a continuous strip of 0.8 mm wide Vitrovac 6006 alloy (from Vacuumschmelz of Germany), to produce strips of deactivatable markers which could be cut to any desired length.

CLAIMS:

1. A magnetically active tag or marker which comprises a substrate; an 'active' magnetic material which is a soft magnetic material having a high  
5 magnetic permeability and a low coercive force; and a deactivating material which is a hard or semi-hard magnetic material having a moderate or high coercive force and a moderate magnetic permeability, whereby the deactivating material, when subjected to a sufficiently  
10 high magnetising force, is able to clamp the magnetic properties of the 'active' material so as to deactivate the 'active' material, characterised in that at least one of said 'active' material and said deactivating material is formed by an electrodeposition process.
- 15 2. A tag or marker as claimed in claim 1, characterised in that said at least one material is formed by electroforming or electroless chemical deposition.
- 20 3. A tag or marker as claimed in claim 1 or 2, characterised in that the 'active' material is a nickel-iron alloy containing at least 60 atomic % nickel and formed by an electrodeposition process.
- 25 4. A tag or marker as claimed in claim 3, characterised in that said 'active' material is an alloy consisting of 75-80 atomic % nickel and 25-20 atomic % iron.
- 30 5. A tag or marker as claimed in any preceding claim, characterised in that the deactivating material is nickel, iron, a nickel-iron alloy, a nickel-cobalt alloy, cobalt, or a cobalt-tungsten alloy.
- 35 6. A tag or marker as claimed in any preceding claim, characterised in that said at least one material is formed as a discontinuous foil or layer or as a plurality of islands carried by a substrate, by means of an electrodeposition process in which selective deposition is achieved by a masking technique.

7. A tag or marker as claimed in any preceding claim, characterised in that said at least one material has a columnar grain structure.

8. A tag or marker as claimed in any one of  
5 claims 1 - 6, characterised in that said at least one material has a planar grain structure.

9. A tag or marker as claimed in 7, characterised in that said columnar grains are coated with a thin layer of planar grains.

10 10. A tag or marker as claimed in any preceding claim characterised in that said at least one material is subjected to a deformation process after being formed by an electrodeposition method.

11. A tag or marker as claimed in claim 10,  
15 characterised in that said at least one material has been subjected to a stamping, rolling, pressing or embossing process.

12. A tag or marker as claimed in claim 10,  
20 characterised in that said at least one material is subjected to mechanical deformation or cold working.

13. A tag or marker as claimed in claim 10, 11 or 12, characterised in that only predetermined areas of said at least one material have been subjected to said deformation process.

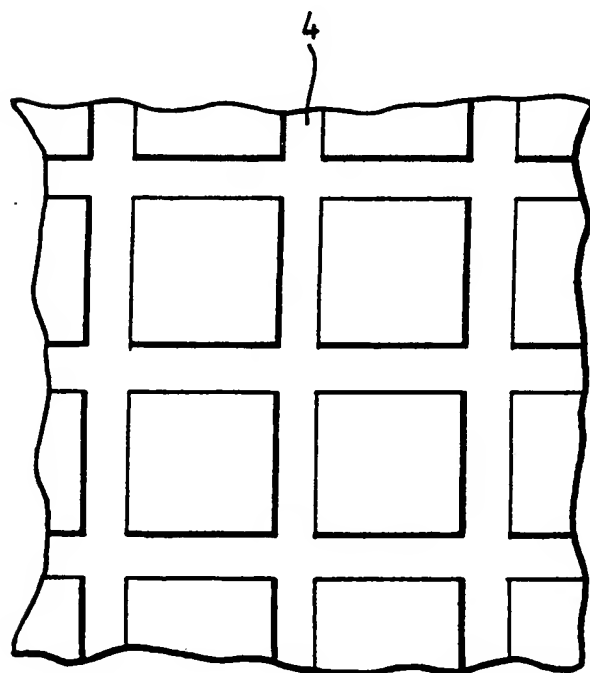
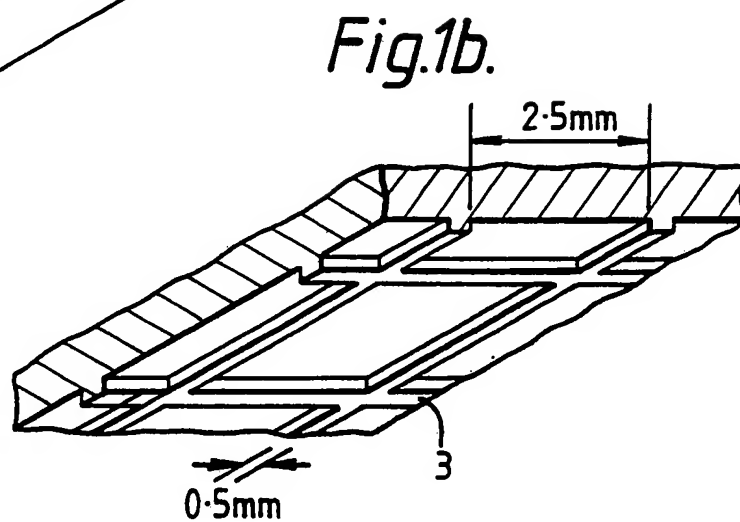
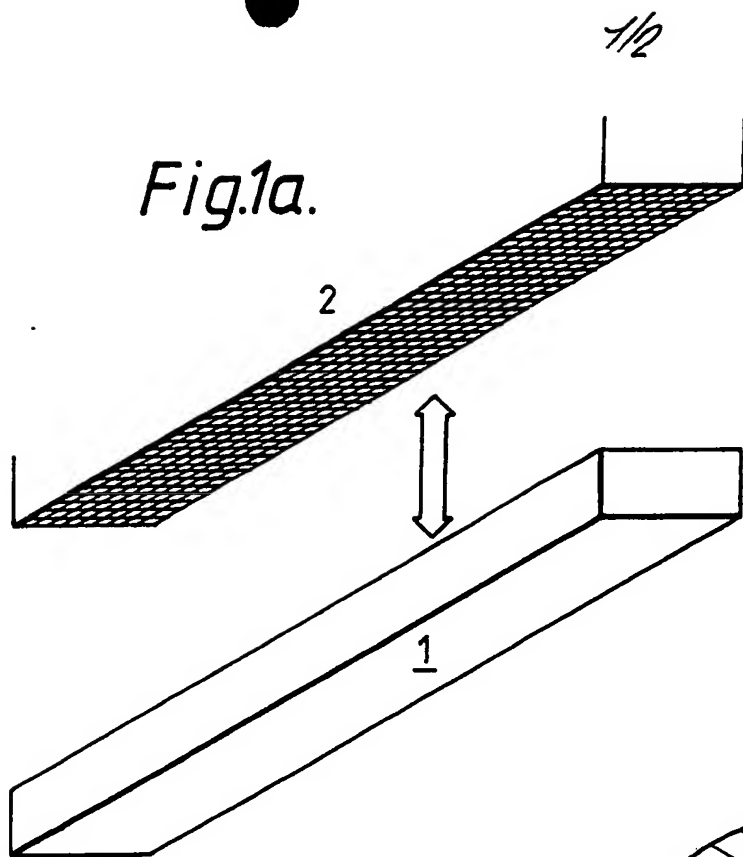
25 14. A magnetically active tag or marker which comprises a substrate; an 'active' magnetic material which is a soft magnetic material having a high magnetic permeability and a low coercive force; and a deactivating material which is a hard or semi-hard  
30 magnetic material having a moderate or high coercive force and a moderate magnetic permeability, whereby the deactivating material, when subjected to a sufficiently high magnetising force, is able to clamp the magnetic properties of the 'active' material so as to deactivate  
35 the 'active' material, characterised in that said deactivating material is a steel which contains 0.15%

carbon; 16-18% chromium; and 6-8% nickel, the balance being iron.

15. A tag or marker as claimed in claim 14,  
characterised in that said steel is cold-worked to give  
5 a coercive force in the range 1000 - 5000 Amp/m and a  
high remanent magnetisation.

16. A tag or marker as claimed in claim 15,  
characterised in that said steel is cold-rolled to a  
reduction of about 50%.





*Fig.2.*

Fig.3.

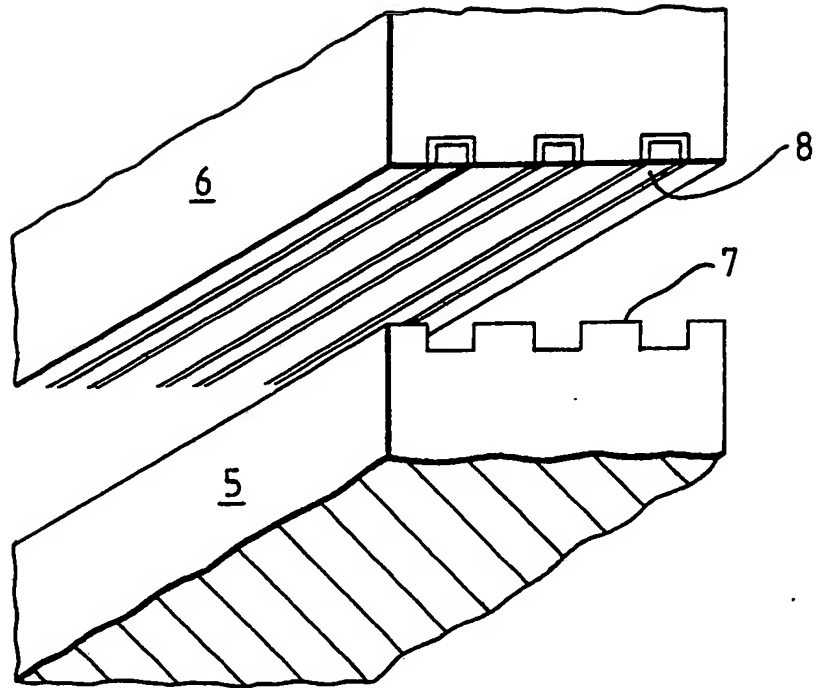
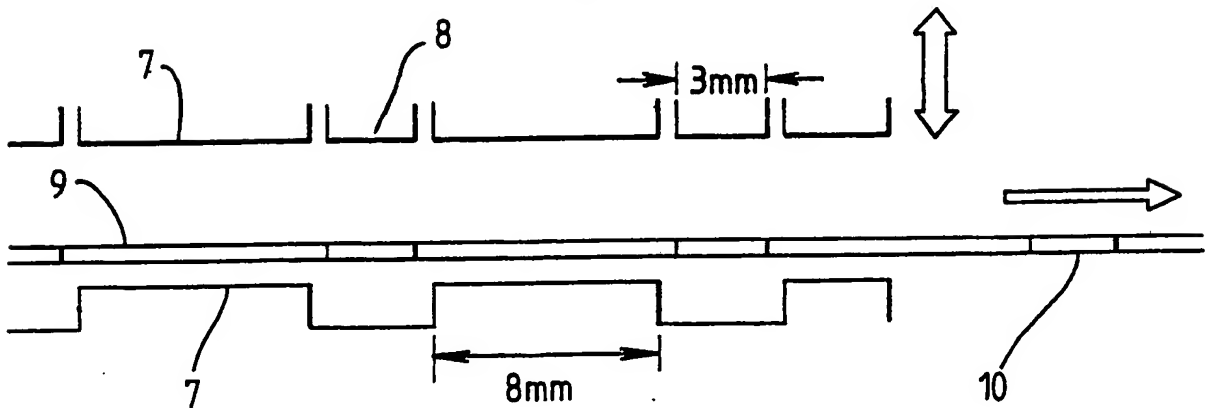


Fig.4.



# INTERNATIONAL SEARCH REPORT

International Application No. PCT/GB 90/00024

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC IPC <sup>5</sup> : H 01 F 41 /26, G 08 B 13/24																																
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched <sup>7</sup></div> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;">Classification System</div> <div style="width: 50%;">Classification Symbols</div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div style="width: 45%;">IPC<sup>5</sup></div> <div style="width: 50%;">H 01 F, G 08 B, G 06 K</div> </div> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin-top: 10px;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched <sup>8</sup></div>																																
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup></b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category <sup>10</sup></th> <th style="width: 70%;">Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup></th> <th style="width: 20%;">Relevant to Claim No. <sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td style="vertical-align: top;">EP, A, 0295028 (SCIENTIFIC GENERICS LTD) 14 December 1988 see page 3, line 9 - page 10, line 6</td> <td style="text-align: center; vertical-align: top;">1,2,5,6</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center; vertical-align: top;">--</td> <td style="text-align: center; vertical-align: top;">3,4,7-16</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">Y</td> <td style="vertical-align: top;">US, A, 4489357 (VAN OOIJEN et al.) 18 December 1984 see column 2, lines 5-61</td> <td style="text-align: center; vertical-align: top;">1,2,5,6</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center; vertical-align: top;">--</td> <td style="text-align: center; vertical-align: top;">1,2,5,6</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="vertical-align: top;">WO, A, 88/09979 (SCIENTIFIC GENERICS LTD) 15 December 1988 see page 11, line 26 - page 13, line 22</td> <td style="text-align: center; vertical-align: top;">1,2,5,6</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center; vertical-align: top;">--</td> <td style="text-align: center; vertical-align: top;">1,2,5,6</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="vertical-align: top;">US, A, 4484184 (GREGOR et al.) 20 November 1984 see column 4, line 64 - column 6, line 19</td> <td style="text-align: center; vertical-align: top;">1,2,5,6</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="text-align: center; vertical-align: top;">--</td> <td style="text-align: center; vertical-align: top;">1,2</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td style="vertical-align: top;">Extended Abstracts/Electrochemical Society, Fall Meeting, 18-23 October 1987, Honolulu, Hawaii, volume 87-2,</td> <td style="text-align: center; vertical-align: top;">1,2</td> </tr> </tbody> </table>			Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	Y	EP, A, 0295028 (SCIENTIFIC GENERICS LTD) 14 December 1988 see page 3, line 9 - page 10, line 6	1,2,5,6	A	--	3,4,7-16	Y	US, A, 4489357 (VAN OOIJEN et al.) 18 December 1984 see column 2, lines 5-61	1,2,5,6	A	--	1,2,5,6	A	WO, A, 88/09979 (SCIENTIFIC GENERICS LTD) 15 December 1988 see page 11, line 26 - page 13, line 22	1,2,5,6	A	--	1,2,5,6	A	US, A, 4484184 (GREGOR et al.) 20 November 1984 see column 4, line 64 - column 6, line 19	1,2,5,6	A	--	1,2	A	Extended Abstracts/Electrochemical Society, Fall Meeting, 18-23 October 1987, Honolulu, Hawaii, volume 87-2,	1,2
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>																														
Y	EP, A, 0295028 (SCIENTIFIC GENERICS LTD) 14 December 1988 see page 3, line 9 - page 10, line 6	1,2,5,6																														
A	--	3,4,7-16																														
Y	US, A, 4489357 (VAN OOIJEN et al.) 18 December 1984 see column 2, lines 5-61	1,2,5,6																														
A	--	1,2,5,6																														
A	WO, A, 88/09979 (SCIENTIFIC GENERICS LTD) 15 December 1988 see page 11, line 26 - page 13, line 22	1,2,5,6																														
A	--	1,2,5,6																														
A	US, A, 4484184 (GREGOR et al.) 20 November 1984 see column 4, line 64 - column 6, line 19	1,2,5,6																														
A	--	1,2																														
A	Extended Abstracts/Electrochemical Society, Fall Meeting, 18-23 October 1987, Honolulu, Hawaii, volume 87-2,	1,2																														
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>10</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 50%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p> </div> </div>																																
<b>IV. CERTIFICATION</b> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">           Date of the Actual Completion of the International Search   <div style="text-align: center;">18th April 1990</div> </td> <td style="width: 50%; padding: 5px;">           Date of Mailing of this International Search Report   <div style="text-align: center;">15. 05. 90</div> </td> </tr> <tr> <td style="width: 50%; padding: 5px;">           International Searching Authority   <div style="text-align: center;">EUROPEAN PATENT OFFICE</div> </td> <td style="width: 50%; padding: 5px;">           Signature of Authorized Officer   <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: right;">Mme N. KUIPER</div> </div> </td> </tr> </table>			Date of the Actual Completion of the International Search  <div style="text-align: center;">18th April 1990</div>	Date of Mailing of this International Search Report  <div style="text-align: center;">15. 05. 90</div>	International Searching Authority  <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer  <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: right;">Mme N. KUIPER</div> </div>																										
Date of the Actual Completion of the International Search  <div style="text-align: center;">18th April 1990</div>	Date of Mailing of this International Search Report  <div style="text-align: center;">15. 05. 90</div>																															
International Searching Authority  <div style="text-align: center;">EUROPEAN PATENT OFFICE</div>	Signature of Authorized Officer  <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: right;">Mme N. KUIPER</div> </div>																															

## III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
------------	--	----------------------

(Princeton, New Jersey, US),  
 D.L. Grimmett et al.: "Electro-  
 deposition of Fe-Ni alloys. I. Invar",  
 page 800, abstract 569  
 see the whole abstract

A US, A, 4661216 (ANDERSON et al.)  
 28 April 1987  
 see the abstract

1

BEST AVAILABLE COPY

# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9000024

SA 33518

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 10/05/90. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0295028	14-12-88	AU-A- 1746388	08-12-88
		EP-A- 0295085	14-12-88
		WO-A- 8809979	15-12-88
		JP-A- 1064207	10-03-89
US-A- 4489357	18-12-84	NL-A- 8102148	01-12-82
		EP-A- 0064786	17-11-82
		JP-A- 57203979	14-12-82
WO-A- 8809979	15-12-88	AU-A- 1746388	08-12-88
		EP-A- 0295028	14-12-88
		EP-A- 0295085	14-12-88
		JP-A- 1064207	10-03-89
US-A- 4484184	20-11-84	US-A- 4298862	03-11-81
		DE-A- 3229334	03-03-83
		GB-A- 2104099	02-03-83
		JP-A- 58039396	08-03-83
		US-E- RE32428	26-05-87
		AT-T- 3596	15-06-83
		CA-A- 1130411	24-08-82
		EP-A, B 0017801	29-10-80
		JP-A- 55143695	10-11-80
		US-E- RE32427	26-05-87
US-A- 4661216	28-04-87	EP-A- 0243627	04-11-87
		JP-A- 62256989	09-11-87